1878MNRAS..38..413P

which light appeared permanently established in the rear of the planet without any distortion of the Sun's limb. Owing to the violent motion, it is possible that this time is one or two seconds too soon, but it is to be noted that my observation of the transit in 1868 left a precisely analogous impression on my mind at the time, namely that there was the reverse of clinging, or that the planet disengaged itself from the limb more suddenly and rather earlier than the progress of the phenomenon led the observer to anticipate. So far as the unfavourable atmospheric circumstances would allow, I note, therefore, no drop or ligament, no bright spot on *Mercury*, no aureola around the planet, and no distortion of either Sun or planet other than as produced by our atmosphere.

At $3^h\ 9^m\ 20^s \pm$ my wife, who assisted me at the observation, first detected the planet against the solar corona, though I had previously looked for it in vain. On taking my station at the telescope a minute later I also detected it, dimly visible, but sufficiently so to direct my attention to the exact point where contact was to take place, and to lead me to suppose that, but for the clouds through which the observation was made, it would have been fairly conspicuous. Full aperture employed 10 inches, focal length 12 ft. 9 in., power 303.

*Orwell Park Observatory,*
*May* 31, 1878.

---

## *Observations of the Transit of Mercury, May* 6, 1878, *at Dunecht Observatory.* By Lord Lindsay and Dr. Copeland.

Until about half-an-hour before the beginning of the transit the day was very fine, with a fresh breeze from the S.S.E. About this time light drifting clouds began to appear, and increased in density until the Sun was at times wholly obscured. Just before first contact, however, the clouds gradually assumed a more fleecy character, and the Sun reappeared with rapidly increasing brightness. Thus it happened that first contact was seen through an appreciable layer of cloud, which was nearly swept away before the planet had fully entered on the Sun's disk. Except perhaps for photographic purposes, the sky was practically clear for the rest of the day.

Five telescopes were used in the observations, besides photographic apparatus. Lord Lindsay and Mr. Ranyard observed with the spectroscope; Mr. Ranyard also made eye observations along with Messrs. H. J. Carpenter, J. G. Lohse, and Dr. Copeland, while Mr. Davis took a series of photographs.

The observations are here given under five heads, in the succession adopted in Lord Lindsay's circular of April 16.

1878MNRAS..38..413P

### *Section* 1.—*Eye Observations of 1st and 2nd Contacts.*

Mr. Ranyard at the time of first external contact was employed with the spectroscope. His time of internal geometrical contact, recorded by an assistant, is $6^{h}\ 2^{m}\ 15^{s}\!\cdot\!5$. Mr. Ranyard remarks: "At the time I called the word *contact*, it seemed to me that the two disks (i.e. the disk of *Mercury* and the Sun's disk) were in geometrical contact. I did not see the bridge of light separating the planet from the limb till about another second had elapsed." The instrument used was the 15·06 inch Grubb refractor, reduced to 10 inches, carrying a power of 380 on a Merz polarizing eye-piece.

Mr. H. J. Carpenter observed with a Newtonian unsilvered glass reflector of 12·9-inches aperture, having a total reflecting prism for the 2nd reflexion. Power used throughout 171. His notes are:—

"Owing to cloud, the first glimpse I got of the planet on the Sun's limb was at $5^{h}\ 59^{m}\ 30^{s}\!\cdot\!5$. By estimating the time when *Mercury* had encroached on the disk as much again as when first seen, I put the time of first external contact at $5^{h}\ 59^{m}\ 14^{s}\!\cdot\!5$ sidereal time. At $6^{h}\ 2^{m}\ 14^{s}\!\cdot\!4$ *Mercury* was fully on the Sun's disk. The time given is that when a thread of light seemed to come between the Sun's limb and *Mercury*; this phenomenon was almost instantaneous. The images were very bad, and I could not say that I detected any ligament or any alteration of the circular form of *Mercury*. I could not see *Mercury* outlined against the sky, nor detect a halo round it."

Mr. J. G. Lohse, using a 4-inch by Cooke, with a power of 60, gives "First external contact $5^{h}\ 59^{m}\ 11^{s}\!\cdot\!8$, probably one second late. Internal contact certainly past at $6^{h}\ 2^{m}\ 17^{s}\!\cdot\!3$; time given probably too late by $15^{s}$ to $20^{s}$. Definition of limbs very bad at internal contact. The observation difficult, on account of a very obvious ligament. In accordance with the foregoing, I put

| | h | m | s |
|---|---|---|---|
| External geometrical contact | 5 | 59 | 10·8 |
| Internal ,, ,, | 6 | 1 | 59·8 |

Dr. Copeland, observing with a 6-inch telescope, object, glass by Simms, mounting by Dallmeyer, and a power of 126-recorded—

| | h | m | s |
|---|---|---|---|
| Just perceptible indentation | 5 | 59 | 12·8 |
| Apparent geometrical contact | 6 | 2 | 7·3 |
| Distinct and instantaneous rupture of ligament | 6 | 2 | 19·3 |

After internal geometrical contact I was surprised to see a distinct clinging between the limb of *Mercury* and that of the Sun, thus forming a distinct narrow ligament. This ligament broke instantaneously at the moment given. The planet was

1878MNRAS..38..413B

then seen at an appreciable distance from the Sun's limb. The ligament was merely a faint grey shading, which might easily have been overlooked. It totally disappeared on breaking.

### *Section 2.—Spectroscopic Observations of Contact.*

Lord Lindsay used a 6-inch Equatoreal by Cooke, within the focus of which was a direct-vision prism.* This threw a dispersed image of the Sun on the slit of an automatic spectroscope, by Browning, capable of giving an effect of from 2 to 10 prisms. The distance between the slit and the direct-vision prism in the tube was 13·1 inches. The length of the direct-vision prism is 3½ inches. These dimensions are measured along the axis of the tube. The slit and the refracting angle of the direct-vision prism being set perpendicular to the Sun's limb, an arc of the Sun's limb depending in length on the power used is seen extending along the spectrum, and in fact tinted with the corresponding colours of the spectrum. In addition the bright lines of the chromosphere are seen projecting beyond the Sun's limb. By moving the telescope any part of the Sun's limb may be made to appear in any colour that may be wished. In this way the point where *Mercury* was expected was brought into the region of the C line.

Immediately before first contact the apparatus was further arranged as follows:—

Light passing twice through two half prisms of the Browning spectroscope, equivalent deviation 103° for line D, dispersion 8° 7'·2 from C to *h*. Magnifying power of eye-piece on viewing telescope 3, giving an effect of 45 on the whole instrument. The recorded observations are

| h | m | s | |
|---|---|---|---|
| 5 | 58 | 13 | Sun's limb barely visible. |
| 5 | 58 | 46·4 | First glimpse of the planet on the reversed C line. |
| 5 | 59 | 0·4 | External contact on the C line. |

The increasing brightness of the Sun rendering an addition to the dispersive power of the spectroscope imperatively necessary, Lord Lindsay made the requisite changes; when this was done it was unfortunately "found that the second contact was lost."

Mr. Ranyard had attached to one of the finders (aperture 3·74 inches) of the 15-inch refractor a Grubb compound prism spectroscope, dispersion C to *h* 5° 40', magnifying power 55. With this instrument Mr. Ranyard, looking for *Mercury* outside the Sun's limb in the red end of the spectrum, could detect no indications of the presence of the planet off the Sun's disk.

---

* Dispersion from C to *h*, 10° 58'·4. In what follows, the magnifying powers and instrumental constants are substituted for the numbers or letters actually recorded by Lord Lindsay; in other respects his notes are strictly reproduced.—R. C.

1878MNRAS..38..413P

## *Section* 3.—*Observations of Cusps.*

No measures of cusps were taken. All the observers agree that no brush or streak of light extending round or partly round the planet was visible during Egress. Except in the case of Lord Lindsay's observations, no indication of the planet was seen outside the limb of the Sun.

## *Section* 4.—*Observations of the Planet when on the Disk of the Sun.*

After an internal contact, the sky becoming still clearer, Lord Lindsay changed the spectroscope to an effective dispersion of 6 prisms, giving 24° 21′·6 from C to *h*, the magnifying power being at the same time increased to 57. $6^h\ 4^m$ and $6^h\ 11^m$ the planet was viewed in the colour of the E line, with the note, "Disk of planet round, sharp, clear, clean."

At $6^h\ 20^m$, with the same arrangements, Lord Lindsay adds: "I see no sort of halo; haze very thick; wide slit." The greatest opening possible is 0·032 inch. Lord Lindsay's further observations are:—

At $7^h\ 7^m$. "Still with 6 prisms but with a power of 136; with this higher power there is a distinct decrease of darkness from the centre of *Mercury* outwards."

At $7^h\ 21^m$. "As before, but viewed on the C line, the shading off from the centre is most marked, with decreased aperture, and shows best with 1·63-inch aperture, mean of 6 measures with the Iris diaphragm."

$7^h\ 50^m$ to $7^h\ 55^m$. "Spectroscope removed; with Browning achromatic eye-piece, power 270, and medium sunshade, I get diffraction rings, with an aperture of 1·42 inch. With aperture 3·45 inches *Mercury* is perfectly clean and round, but, whether from contrast or not, the limb is decidedly brighter, or rather less dark than the centre."

$8^h\ 5^m$ sid. time. "I have just tried powers 92 and 174, and find the shading much less apparent than with a higher power. With a power of 382 it is marked. I get no trace of a bright spot."

"No satellite."

With an aperture of 10 inches and powers 244, 381 and 563, Mr. Ranyard looked carefully for rings round the planet or spots upon its disk, without seeing either. When the image of the planet was thrown on the slit of the finder spectroscope no other change was perceptible except the appearance of a black streak traversing the spectrum from end to end, caused by the interruption of the light.

Mr. H. J. Carpenter says: "I could not see *Mercury* outlined against the sky, nor detect a halo round it, nor a satellite, although I looked carefully with the 15-inch (reduced to 10 inches), as well as with the reflector."

1878MNRAS..38..413P

Dr. Copeland found the planet plainly visible with so small an aperture as 0·4 inch, but much shaded off at the limb. This seems to be the chief effect of applying small diaphragms. With an aperture of 0·95 inch some traces of a bright spot in the centre of the planet's disk were perceived. With the same aperture and telescope Mr. Ranyard thought he saw a greyish ring round the planet. It was the only diaphragm that produced any trace of a bright central spot.

Mr. J. G. Lohse, with the 4-inch Cooke, power 60, measured the distance of the centre of the planet from the Sun's limb, as follows:—

| Dunecht Mean Time. | | | Dist. | | Position Angle. |
|---|---|---|---|---|---|
| h | m | s | ′ | ″ | ° |
| 3 | 7 | 52·2 | 0 | 20·73 | 45 |
| | 12 | 50·2 | 0 | 38·84 | 45 |
| | 16 | 17·2 | 0 | 56·61 | 45 |
| | 20 | 38·3 | 1 | 14·45 | 43·7 |
| | 30 | 18·3 | 1 | 46·44 | 43·7 |
| | 32 | 20·3 | 1 | 56·83 | 43·7 |
| | 36 | 31·3 | 2 | 9·35 | 41·73 |
| | 40 | 26·3 | 2 | 24·56 | 41·73 |
| | 44 | 8·3 | 2 | 37·15 | 41·73 |
| | 49 | 30·3 | 3 | 2·97 | 41·73 |

And the diameter of *Mercury*—

1st. With the full aperture—

10″·87 ± 0″·29, 5 measures.

2nd. Aperture reduced to 1·7 inch.

11″·98 ± 0″·16, 12 measures.

Dr. Copeland, with a power of 126 on the 6·06-inch Simms object-glass, found the diameter of *Mercury* to be as follows:—

| Diam. of ☿. | Aperture. | Pos. Angle. | No. of meas. |
|---|---|---|---|
| ″ | in. | ° | |
| 10·84 | 6·06 | 45 | 2 |
| 10·73 | 3·60 | 124 | 4 |
| 10·53 | 3·60 | 34 | 8 |
| 9·40 | 0·95 | ... | 1 |

The twelve measures with the aperture reduced to 3·6 inches give a mean of 10″·597±0″·099, corresponding to a diameter of 5″·916 at the mean distance of the Sun.

Mr. H. J. Carpenter, with the 12·9-inch reflector and a power of 171, obtained measures of the diameter of *Mercury* with a mean result of 12″·43.

All the observations have been corrected for refraction where

1878MNRAS..38..413P

necessary, and the periodic errors of the screws have been eliminated.

### 5. *General Remarks.*

As a check on the values of the micrometer screws used to measure the size of *Mercury*, the chief pair of Σ 1090 has been measured:

1. By Mr. J. G. Lohse with the 4-inch:

Distance 60″·69 ± 0″·39; 12 measures.

2. By Dr. Copeland with the 6·09-inch:

Distance 60″·80 ± 0″·11; 11 measures.

Position 98°·08 ± 0°·11; 16 measures.

As a further check the same pair of stars were measured by Mr. J. G. Lohse with the Grubb 15-inch, full aperture.

Distance 60″·57 ± 0″·12; 9 measures.

Position 97°·56 ± 0°·08; 9 measures.

A combination of these determinations gives for Σ 1090

1878·37 Dist. 60″·685, Pos. 97°·73, A and B.

One measure of distance and two of position with the 6-inch gave for the third star

1878·37 Dist. 20″·82, Pos. 319°·75, B and C.

With the same telescope A was 7·9 mag. yellowish, B 8·5 white, and C 10·5 mag.

The hour angle was too great and the companion stars unfortunately too faint to be measured with the unsilvered reflector.

The focal lengths of the telescopes used are approximately as follows:—

| | | in. |
|---|---|---|
| 15·06 | Grubb refractor | 183·2 |
| 12·9 | Reflector | 122·5 |
| 6·06 | Simms refractor | 74·5 |
| 6·04 | Cooke ,, | 90·3 |
| 4·00 | ,, ,, | 59·5 |
| 3·74 | Grubb finder | 43·8 |

The best four of about twenty photographs have been measured, but the final results have not yet been deduced. It is worthy of remark that the image of *Mercury* appears much

1878MNRAS..38..420R

smaller in the photographs than it did on the ground glass of the camera.

The latitude of Dunecht by transit-circle observations is 57° 9′ 36″; the longitude, taken from the Ordnance Survey map, is $9^m\ 40^s$ west of Greenwich. The time was determined with the transit circle on several nights both before and after the day of the transit. Unless otherwise stated, the times are given in Dunecht sidereal time.

*Dunecht, June* 12, 1878.

## *Observations of the Transit of Mercury of* 1878, *May* 6.

By A. C. Ranyard, Esq.

The transit was observed by me at Dunecht. Lord Lindsay kindly gave me the use of his 15-inch refractor, which was stopped down to ten inches during the observation, in order to avoid all chance of damaging the eye-pieces or dark shades by the Sun's heat. On one of the finders was a spectroscope, with a single compound prism, by Grubb, with a dispersion of 5° 56′ from *B* to *h*. On the other finder was a low-power eye-piece, with cross wires, which were brought into accurate collimation with the centre of the slit of the spectroscope. On the large instrument was a Merz polarising eye-piece, giving a power of 244.

As the planet came up to the Sun's limb, from about ten minutes before the time of predicted contact, I observed the spectrum of the sky in the direction in which the planet was approaching. The viewing telescope of the spectroscope was turned so that the red end of the spectrum below C was in the field of view, and the slit of the spectroscope, which subtended an arc of 5′ 45″ upon the Sun, was nearly at right angles to the path of the approaching planet. The slit was swept outward in right ascension over the path of the planet, and any variation in the brightness of the field corresponding to the place of the planet was carefully looked for. My reason for attempting this observation was that M. Janssen, in observing the transit of *Venus*, thought that by making use of a screen of blue glass he had been able to detect the body of the planet projected upon the background of the corona some time before it was visible without the screen. As far as I am aware, there are no observations which indicate that the spectrum of the lower parts of the corona is richer in blue rays than the spectrum of the light derived from the veil of illuminated particles floating in our own atmosphere, which under ordinary circumstances hides the corona from our view. Indeed the evidence is rather in the contrary direction, for Mr. Stone, observing during the total eclipse of April 1874, was of opinion that the continuous spectrum of the lower parts of the corona was rich in red light. I therefore